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The Physiological Effects of a Cross Country Bike Ride on Novice Cyclists

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THE PHYSIOLOGICAL EFFECTS OF A CROSS COUNTRY BIKE RIDE ON NOVICE CYCLISTS

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By

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ABSTRACT

Purpose: The physiological responses and adaptations experienced by novices engaging in cross-country cycling have received little attention in the scientific literature. Such endeavors typically involve a sizeable increase in physical activity for most individuals, but the acute and chronic effects of such an endurance feat are not well understood. Similarly, research shows that experienced cyclists often demonstrate osteoporosis in the spine, linked to many years of training accompanied by little or no weight bearing stress upon the axial skeleton. Greater understanding of these issues is needed, as long distance cycling has increased in popularity in recent years, and exercise professionals increasingly supervise their training. This study explored the effects of 60 days of cycling upon measures of aerobic capacity (AC), bone mineral density (BMD) and body mass composition (BMC) of novice cyclists, as well as in a group of controls.Methods: Five novice cyclists (21.0.2 ± 0.71 yr, 187.842 ± 6.50 cm, 82.84 ± 5.42 kg) completed laboratory testing prior to and after the cross-country trek, as did controls (20.2 ± 1.79 yr, 178.31 ± 4.17 cm, 78.34 ± 7.55 kg). Members of both groups visited the laboratory on two occasions, 60 days apart. Each completed a graded exercise test and DEXA scan, assessing measures of AC, BMD, and BMC. Two-way repeated measures ANOVA were used for statistical analysis. **Results:** For AC ($VO_{2\ max}$), significant differences were found pre-post within both groups ($F(1,8) = 5.418$, p =

0.048), with the cyclists improving and the controls decreasing in AC. Non-significant differences were found pre- and post-ride for the following measures of BMD: whole body ($F(1,8) = 0.34$, $p = 0.57$) and lumbar region ($F(1,8) = 0.72$, $p = 0.42$. Measures for whole body and lumbar region were decreased following the ride across the country. Significant differences for BMC were found between the following measures: left arm fat mass ($F(1,8) = 8.42$, $p = 0.02$, left arm lean mass ($F(1,8) = 6.16$, $p = 0.04$), left arm fat percentage ($F(1,8) = 38.72$, $p = 0.00$), right arm lean mass ($F(1,8) = 6.32$, $p = 0.04$), right arm fat percentage ($F(1,8) = 41.78$, $p = 0.00$), trunk fat mass ($F(1,8) = 5.45$, $p = 0.048$), right leg fat mass ($F(1,8) = 9.04$, $p = .02$), and total fat mass ($F(1,8) = 13.48$, $p = 0.01$).

Conclusions: These results have scientific and practical relevance given the few studies on the effects of cross-country cycling upon physiological fitness in novice cyclists. These findings suggest that novice cyclists significantly increased their aerobic capacities as an adaptation to an extended ride across the United States. These results suggest non-significant changes in BMD occurred among these cyclists. These participants also demonstrated significant changes in some BMC measures. More study is needed on the impact of prolonged cycling upon measures of AC, BMD, and BMC among novice cyclists.

Keywords: prolonged cycling, aerobic capacity, bone mineral density, body mass content

Dedicated to my parents

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CHAPTER 1

INTRODUCTION AND BRIEF REVIEW OF LITERATURE

It is not uncommon for either recreational or competitive cyclists to engage in heavy exercise on a daily basis. Each may also, endure heavy physical activity levels for many days over an extended period. In this vein, recreational and competitive cyclists are known to engage in extended bicycle rides across the United States, for a variety of reasons. These rides usually take at least a couple of months to complete, and they typically consist of long daily rides ranging from 30-100 miles in duration.[7] Such extended rides present a unique opportunity to study the the human body's response and adaption to physical activity.

More specifically, a bicycle ride across the United States to raise awareness of Alzheimer's disease provided a unique opportunity to study abrupt increases in exercise intensity and volume experienced by such participants. While there has not been extensive work conducted on the physiological responses to prolonged endurance events, some research has been done in the area. For example, the fastest finishers in ultramarathon running events tend to be adults between 40-45 years of age, and men and women tend to differ in performance by approximately 20 percent.[19,20] In a study monitoring the heart rate response of elite cyclists racing across the Alps, authors found that a substantial decrease in heart rate response of approximately 10% every 10 hours is

a characteristic of ultramarathon cycling.[21] A related report noted that despite the considerable demands of ultramarathon cycling, renal function and plasma volume are only minimally affected immediately following such an event.[22] Conversely, a study by Knechtle et al. found a moderate association between anthropometry and race performance, rather than with prior training volume, in male ultra endurance cyclists.[23] Such discrepancies in the existing literature regarding the impact of training volume upon performance suggest that further study is warranted on the demands of prolonged endurance events. Each of these studies focused on the physiological responses to prolonged endurance events. More study is needed on the physiological adaptations experienced by participants during such endeavors.

Further study on physiological adaptations to prolonged endurance events may be accomplished by assessing widely acknowledged attributes of human performance. For example, cardiorespiratory function is widely accepted as a basic component of physical fitness, and aerobic capacity is commonly assessed in laboratory environments through the measurement of pulmonary ventilation characteristics (e.g. VO_2 max, or aerobic capacity) during a graded exercise test.[10] Authors also point to the benefits of regular exercise upon musculoskeletal system, muscle strength and endurance, muscular flexibility, joint health, and bone mineral density.[10] Cycling peak power output has been shown to increase with a cycling program of 12 weeks or more, [24], and this can be assessed also via laboratory testing. Habitual exercise is also linked to decreased body fat stores.[25] Conversely, road cycling has been shown to deceased bone mineral density in specific anatomical regions, such as the lumbar spine.[26] Body composition and bone mineral density can also be tested using laboratory methods. Novice cyclists riding

bicycles across the country to raise money for Alzheimer's research presented a unique opportunity to assess the physiological adaptations of such an endeavor.

Following an extensive review of the scientific literature, it is evident that little research has been done on physiological markers in response to cross-country cycling. Research in this area would help to explain how young, apparently healthy adults respond to the demands of such heavy exercise. In this context, much research has linked regular physical activity to many health benefits - to the extent that many professional and governmental organizations promote exercise as an important societal aim.[28,29] Conversely, many reputable sources have linked heavy physical activity levels to disruptions in fitness levels as well as to more serious health conditions.[1,3] Further study is needed on the effects of heavy training loads upon on young, apparently healthy adults.

In summary, few studies exist on the influence of cross-country cycling upon fitness measures among participants who take on such an endeavor. Apparently healthy young men likely undergo many changes in health and fitness markers during an extended trip of this type. Little is known about how such markers may change over the course of days, weeks, or months when individuals participant in such endeavors of extended physical activity. In this vein, assessing recreational cyclists who rode across the country to raise money for Alzheimer's disease presented a great opportunity to study their physiological response and adaptation to a profound increase in physical activity. Thus, the primary aim of this study was to examine the effects of a cross-country cycling event upon physiological markers exhibited within t novice cyclists. Numerous laboratory measures of fitness were collected on these participants, prior to and following their completion of this extended bout of physical activity. We hypothesized that

participants would likely demonstrate significant differences in some laboratory measures collected prior to and following this event.

CHAPTER 2

METHODS

Experimental Approach to the Problem

The purpose of this study was to investigate the effects of cross-country cycling on numerous physiological measures within novice cyclists. This study used a quasi-experimental design, as a sample of opportunity was used to recruit participants for this study on the physiological effects of cross-country cycling. A group of controls was also recruited, allowing for comparisons between the "experimental" (i.e. cross-country cyclists) and "non-experimental" (i.e. age-matched controls) participants within the study. Commonly used statistical testing was conducted as a means of assessing the findings for statistically significant differences and for relevance in practical application.

Participants

The sample for this study was one of opportunity, based on the unique chance to study the physiological responses and adaptations within of a group of young men who traveled across the country on bicycles to raise money for research on of Alzheimer's disease. Selection for inclusion in the experimental group occurred many months prior to the study, originating out of a community service endeavor planned by the members of a social fraternity at WKU. Ten young men (n = 2010) departed from WKU in late May

2014 to embark on this cross-country bicycle ride, and five members (n = 5) of this group (21.0.2 ± 0.71 yr, 187.842 ± 6.50 cm, 82.84 ± 5.42 kg) participated in pre- and post-ride testing conducted within a WKU laboratory. For this study, we recruited five (n =5) additional healthy, physically fit males (20.2 ± 1.79 yr, 178.31 ± 4.17 cm, 78.34 ± 7.55 kg)between the ages of eighteen and thirty to serve as age-matched controls, who remained in the local area and engaged in their usual activities throughout the same time duration as the cross-country cyclists. The controls were recruited by postings on bulletin boards on the Western Kentucky University campus, e-mailing fellow students, as well as word of mouth (Appendix I). As a requirement for participating in the study, our population fulfilled all the inclusion criteria and did not possess any of the exclusion criteria as listed in Appendix II and as screened via Appendix III. All cross-country cyclists and controls signed informed consents prior to participation (Appendix IV and Appendix V, respectively), in compliance with federal guidelines involving human participants and administered by the Institutional Review Board (IRB) at Western Kentucky University.

Instruments

The following lab instruments were used to collect data on the participants in the study, prior to, and after, the ride across the United States:

American College of Sports Medicine (ACSM) Risk Stratification Index

Risk stratification was determined by the standards set by the American College of Sports Medicine (ACSM). The participant's answered the questions allowing us to establish the risk category (low, moderate, or high) of each participant. Only participants

classified as low risk were allowed to participate in this study (Appendix II).

ParvoMedics TrueOne 2400.

Aerobic capacity is widely acknowledged as a measure of cardiorespiratory fitness. The VO_2 peak test is typically used to assess the aerobic capacity of research participants, as it measures the peak oxygen uptake of a participant during a graded exercise test GXT). While there are several methods to measure VO_2 peak, the ParvoMedics TrueOne2400 (ParvoMedics, Sandy, UT, USA) metabolic measurement system is considered gold standard testing equipment, and it has been deemed valid and reliable for physiological testing.[30] Respiratory gases were collected during this testing and monitored using the ParvoMedics TrueOne 2400. The metabolic measurement system was calibrated prior to each test with room air and standard gases (O_2 and CO_2) of known volume and concentration. Respiratory gases were collected by a mouthpiece attached to headgear to hold it in place. Participants wore a nose clip to ensure that gas exchange is only occurring through the mouth. The metabolic cart software reported the values as ventilated oxygen and carbon dioxide.[31]

DEXA Scan (Dual X-Ray Absorptiometry) Hologic Discovery A

Body composition is widely acknowledged as a basic component of fitness, and bone mineral density is also widely considered a measure of health. Low bone mineral density (BMD) is a serious public health problem, and researchers have established links between cyclists and low BMD.[32,33,34] Body composition and bone mineral density in this study were assessed using dual energy x-ray absorptiometry (DEXA). The Hologic Discovery A (Hologic, Inc. Bedford, MA, USA) and software version 12.4 was used in this study. This instrument have been found valid and reliable for assessment of body

composition and BMD.[35] Measurements collected during this assessment included: lean mass, fat mass, bone mineral content and percentage total body fat. Participants entered the room wearing appropriate wear for the test with no metal and all artifacts removed from the body. Participants then laid supine on the table, centered in the scan field with arms at their sides, palms down and thighs separated. Legs were rotated inward 25 degrees until their toes touch each other and then lightly strapped together to maintain this position. The body scan was analyzed to determine body composition and BMD.

OMNI Rating of Perceived Exertion.

Rating of perceived exertion (RPE) is a subjective measurement originally described and validated by Borg as a means of scaling the effort level during physical activity. The OMNI rating of RPE (Appendix VI) utilizes images that show facial expressions of exertion and body position of the participant for the participant to grade his or her level of exertion. Such an instrument allows researchers and clinicians to determine the participants perceived level of intensity with the given exercise. The OMNI has been determined to be both reliable and valid for measuring an individual's perception of effort during cycling.[36]

Computrainer™ and Spinscan™ Software

The CompuTrainer™ Lab Pro 3D (RacerMate, Seattle, WA, USA) is an electronically braked ergometer suitable for use in the laboratory or many environments beyond the laboratory. The CompuTrainer™ is a well-known and widely used ergometer that is utilized by cyclists, coaches, and scientists worldwide to help improve cycling technique and performance. Its proprietary software applications, such as the SpinScan Pedal Stroke Analyzer™, allow for detailed analysis of many aspects of cycling

performance. Studies have found the CompuTrainer™ to be both valid and reliable when utilized as a bicycle ergometer,[37,38] and it is widely used in peer-reviewed studies.[39,40,41]

The Computrainer™ provides a means of precisely measuring the gross motor coordination within the participants and between the conditions used in this study. The Computrainer and its software were used in this study to measure a number of dependent variables, such as the SpinScan (SS), Average Torque Angle (ATA), revolutions per minute (RPM), wattage (W), and the percentage of relative contribution of the legs under these different conditions.

The Computrainer™ can be administered on a variety of bicycles, including commonly available road and off-road bicycles, and this is one of the appealing aspects of this ergometer, as it allows scientists and coaches to analyze cycling performance on the rider's own bicycle. In our study, the participants riding across the country completed the graded exercise test using their own bicycles, and the members of the control group performed the graded test on a Serotta Fit Cycle™ (Serotta, Saratoga Springs, NY, USA). The Serotta Fit Cycle™ was utilized to standardize conditions for the non-cyclists who comprised the control group. This instrument allows for easy adjustments to the various heights of our participants yet remains relatively constant between trials. For this study, the seat tube was angled at 78 degrees. Further, the seat was positioned parallel to the ground with the seat height being determined using the method described by Lemond.[42]

Procedures

Initial Screen:

Prior to testing, participants underwent a series of screenings to test for possible exclusion criteria that would have prohibited them from engaging in the study. They first answered questions on a detailed medical screening form that determined whether they were at risk for coronary artery disease or showed signs and symptoms of cardiovascular, pulmonary, or metabolic disease (Appendix III). Under the conditions that the individual completed the screening process, meet the necessary criteria, and was willing to participate, he then read and signed an informed consent document. One informed consent document was used prior to testing the individuals who participated in the cross-country cycling event (Appendix IV). Another informed consent was used prior to testing the individuals who served as age-matched controls (Appendix V). The informed consent document was created by the researchers and complies with the federal guidelines set for research pertaining to human subjects and reviewed by the Institutional Review Board at Western Kentucky University. The individuals who participated in this study were voluntarily engaged in this study and were aware that they would not receive compensation for their time.

During the initial screen, individuals were instructed to refrain from a number of activities or practices in the hours prior to the data collection sessions as a means of standardizing the process and minimizing the potential for threats to internal validity. First, individuals were instructed to avoid strenuous activity and alcohol consumption in the 24 hour period previous to each data collection session.[51,52] Second, individuals were instructed to refrain from carbonated and/or caffeinated products for at least 12 hours prior to each data collection session.[53] Third, individuals were instructed to refrain from eating for 12 hours prior to each data collection session.[54,55] Fourth, individuals were

asked the following questions prior to pre-testing and post-testing: "How much fluid of you ingested over the last 24 hours?" "How much fluid have you ingested over the last 3 hours?" "What have you eaten over the last 24 hours? " What have you eaten in the last 3 hours?" Each of these factors has the capacity to alter human performance as well as the accuracy of its measurement. Participants involved in the cross-country bicycle ride were also instructed to bring their own bicycle, cycling shoes, and typical cycling attire for the testing sessions.

Lab testing - Data Collection:

Individuals who passed the initial screen traveled to the Human Performance Laboratory within the Doctor of Physical Therapy Program at Western Kentucky University on two separate testing dates. The first date occurred prior to the bicycle ride across the United States, and the second date occurred following this event. During the first visit to the laboratory, a member of the research team reviewed the inclusion/exclusion criteria with the individual to verify his or her suitability for participation in this study. A member of the research team then provided the individual with a copy of the Informed Consent for this study and offered to answer any questions to the individual's satisfaction. Data collection began upon receipt of the signed Informed Consent, and participants were given a copy of their signed Informed Consent.

The initial session included the collection of a number of variables. Physiological data such as height, weight, sum of skin folds and body mass index (BMI) was collected (Appendix VIII). Vital signs such as resting heart rate and blood pressure were also assessed. The participant's bicycle were also measured and weighed, and at this time during both sessions the tire pressure was standardized by setting it to the standardized

pressure printed on the sidewall of the tire. The participant's bicycle then was mounted to the Computrainer™ system. A number of these variables – such as body weight, heart rate, resting blood pressure, and tire pressure – were measured and standardized for the 2nd data collection session as well.

Following the collection of the basic anatomical and physiological data, the Computrainer™ used in this study was calibrated according to the manufacturer's specifications[56]. The participant was then fitted with the mouthpiece and nose clip that comprise part of the ParvoMedics TrueOne 2400 system. The heart rate monitor was also fitted. Each participant then performed a 10-minute warm-up at a standardized workload (150 W) in order to become familiar with cycling on the Computrainer™. This warm-up also allowed the participant to become accustomed to exercising while wearing the mask and nose clip, as well as to ready the body for the high-intensity exercise of this data collection session. An incremental exercise test to maximal capacity followed this familiarization and warm-up period.

Aerobic capacity (AC), or VO_2 peak, was assessed using a standardized incremental exercise to maximum protocol (Appendix VII). During the protocol, each rider cycled against a "base resistance" of 50W, and he began the ramp protocol at 0% grade. The grade increased 1% every 2 minutes, increasing the effort necessary to remain pedaling. Every two minutes the grade was increased until the participant failed to maintain a minimum pedaling cadence of 60 revolutions per minute (rpm). Participants were expected to remain seated ("in the saddle") at all times during the testing.

Ventilation, gas exchange, and heart rate measures were recorded by the ParvoMedics TrueOne 2400 during the incremental exercise to maximum testing

protocol. The following variables were assessed continuously (30s avg) during each trial: VO_2, VCO_2, VE, METs, RER, VT, FEO_2, $FECO_2$, and HR. Spinscan and other measures relevant to neuromuscular efficiency while cycling were recorded by the Computrainer™ used in this testing.

Body composition and bone mineral density measures were collected using the Hologic DEXA. Each participant underwent three scans: a whole-body scan for body composition and bone density, a bone density scan of the axial skeleton, and a bone density scan of the femurs. Participants entered the room wearing appropriate attire for the test, with no metal (e.g. zippers, etc) and all artifacts removed from the body. Participants then laid supine on the DEXA table, centered in the scan field with arms at their sides, palms down and thighs separated. Legs were rotated inward 25 degrees until their toes touch each other and then lightly strapped together to maintain this position. Testing of each participant for bone mineral density and body composition took e approximately 10 minutes.

Data Analysis

Data collected was entered into a software application (Excel, Microsoft Corporation, Redmond, Washington) and configured for statistical analysis. All data collected in this study used standard methods to ensure the confidentiality of participants. Code numbers were used to de-identify the participants, and the master code was stored as a separate document on a password protected computer maintained by WKU. Data collection sheets (Appendix VIII) identified participants solely by number, as id computer files containing data on the dependent variables included in this study (Appendix IX).

Statistical analysis was conducted using SPSS 21.0 (IBM SPSS, Armonk, NY). Two-way repeated measures ANOVA were used to assess the data for statistically significant differences ($p \leq 0.05$) within the cross-country cyclists before, during, and after the ride across the country, as well as to make comparisons between the cross-country cyclists and the control group.

CHAPTER 3

RESULTS

The purpose of this study was to assess for physiological adaptations exhibited by novice cyclists who engaged in a cross-country bicycle ride. A number of significant and non-significant differences were found for the variables used in this study.

Regarding measures of aerobic fitness, two primary variables were assessed: Aerobic capacity (AC) and time to volitional failure (TVF) during the graded exercise test. For AC ($VO_{2\ max}$), significant differences were found pre-post within both groups ($F(1,8) = 5.418$, $p = 0.048$), with the cyclists improving and the controls decreasing in AC. Significant differences in AC were also found between the groups ($F(1,8) = 43.815$, $p = 0.00$). For TVF, significant differences were also found pre-post within both groups ($F(1,8) = 33.108$, $p = 0.000$), with the cyclists improving and the controls backsliding in TVF. Significant differences in TVF were also found between the groups ($F(1,8) = 46.401$, $p = 0.00$). These findings are also depicted in Table 1.

Ratings of perceived exertion (RPE) were also assessed (Table 2). Significant differences were found between pre- and post- conditions ($F(1,4) = 986.13$, $p = 0.00$) for OMNI RPE scores during a maximal cycle test. Significant differences were also evident for interactions between condition (pre vs. post) x group (cyclists vs. controls) ($F(1,4) = 43.20$, $p = .003$).

A number of variables were assessed regarding measures of bone mineral density (BMD) and body mass composition (BMC). Non-significant differences were found pre- and post-ride for the following measures of BMD: whole body ($F(1,8) = 0.34$, $p = 0.57$) and lumbar region ($F(1,8) = 0.72$, $p = 0.42$. Measures for whole body and lumbar region were decreased following the ride across the country. Significant differences for BMC were found between the following measures: left arm fat mass ($F(1,8) = 8.42$, $p = 0.02$, left arm lean mass ($F(1,8) = 6.16$, $p = 0.04$), left arm fat percentage ($F(1,8) = 38.72$, $p = 0.00$), right arm lean mass ($F(1,8) = 6.32$, $p = 0.04$), right arm fat percentage ($F(1,8) = 41.78$, $p = 0.00$), trunk fat mass ($F(1,8) = 5.45$, $p = 0.048$), right leg fat mass ($F(1,8) = 9.04$, $p = .02$), and total fat mass ($F(1,8) = 13.48$, $p = 0.01$). Significant difference between conditions and groups were found for trunk fat percentage ($F(1,8) = 10.58$, $p = 0.01$), left leg fat percentage ($F(1,8) = 9.015$, $p = 0.17$), and total fat percentage ($F(1,8) = 9.33$, $p = 0.02$). All other measures of regional and total body BMC were not significantly different. These findings are detailed in Table 3.

CHAPTER 4

DISCUSSION

The purpose of this study was to assess for physiological adaptations exhibited by novice cyclists who engaged in a cross-country bicycle ride. We hypothesized that the novice cyclists would demonstrate improved aerobic fitness measures following the cross-country ride. We also hypothesized that the novice cyclists would showed changes in BMD and BMC over the course of this event.

The findings of this study in relation to AC and TVF were consistent with findings in previous studies, indicating that aerobic performance measures improve with habitual training. All participants that embarked on the cross-country cycling trip significantly improved both their AC and TVF. Whereas our matched controls, did not improve either AC or TVF significantly. These findings have meaningfulness in clinical or athletic setting. Practically it suggests that if a novice, untrained individual begins vigorous aerobic exercise and continues it for a significant amount of time, he or she will exhibit improved measures of cardiovascular fitness, More studies need to be conducted on this topic to monitor the response and adaptation to cross-country cycling among novice participants. These findings also clearly document that the participants were able to perform maximal exercise for longer periods of time, indicating that they demonstrated physiological adaptations to the stressor of a cross-country ride. Athletically, these

findings are meaningful because it suggests that performance can improve with long bouts of vigorous training. If an aerobic athlete can improve their AC and TVF then they will be able to perform harder for longer periods of time. At first glance, these findings may seem obvious; however, this study is the first known to document these types of adaptations within novice cyclists.

The findings of this study in relation to RPE were consistent with findings in previous studies, indicating that RPE measures improve with habitual training. All participants that embarked on the cross-country cycling trip significantly improved their RPE measures during graded exercise testing; in contrast the matched controls did not improve significantly on this measure during pre- and post-testing. These findings have meaningfulness in clinical or athletic settings. Practically it suggests that if a novice, untrained individual begins vigorous aerobic exercise and continues it for a significant amount of time, he or she will exhibit improved measures of effort during high intensity exercise. More studies need to be conducted on this topic to monitor the response and adaptation to cross-country cycling among novice participants.

The findings in the present study on novice cyclists contradict previous research regarding changes in BMD in highly competitive cyclists. Prior research has shown that BMD can be depleted in experienced cyclists. Within the novice cyclists in this study, no BMD measurements were found to be significantly different. Readings of the lumbar spine, femoral head, total body and femoral neck have shown the greatest variance of BMD in past studies, but no significant change in these measures was recorded in this study. This finding suggests that BMD did not significantly change with a bout of cross-country cycling lasting roughly two months. While no statistically significant measures

were found,, small changes were observed in these measures, suggesting that such changes in BMD dot no happen over the relatively short amount of time involved in the present study. Consequently, these findings suggest that future study should investigate novice cyclists that use cycling as their main mode of exercise for a longer duration of time than the 56 days that our participants cycled. Similarly, , a larger pool of participants would increase the statistical power for a follow-up study employing a duration commensurate with the present investigation. .

The present findings are consistent with many studies suggesting that changes in BMC are noted when physical activity levels are increased. Previous investigations have reported that high intensive activities in particular are linked to changes in BMC (quote from poster). However, the greatest significant differences found in this study were not in total body composition, instead significant differences were found in left arm lean mass, left arm total mass and right arm fat percentage. These results deepen our understanding of the physiological responses of novice cyclists participating in prolonged endurance cycling. These finding may help sport scientists and coaches develop training programs for maintaining bone and body composition health among endurance cyclists.

The greatest strength of this study is that it assessed the physiological responses and adaptations of individuals who engaged in a substantial increase in physical activity levels. Such abrupt increases in exercise levels are not an everyday occurrence nor are they typically documented, thus this study provides insights into this process. The weakness in this study is centered on the small sample size of opportunity. As is the case with any research study, a larger sample size provides greater confidence in the veracity

of the results. Future study on this topic might be conducted so as to recruit a larger number of cyclists who participate in such a cross-country endeavor.

CHAPTER 5

CONCLUSION

No none studies previously assessed the on the effects of cross-country cycling on measures of cardiovascular fitness or bone and body composition fitness. These results have scientific and practical relevance given the few studies on the effects of cross-country cycling upon such measures within novice cyclists. These findings suggest that novice cyclists significantly increased their aerobic capacities and time to volitional failure as an adaptation to an extended ride across the United States. These findings are consistent with the many reports indicating that aerobic performance measures improve with habitual training. Exercise professionals are encouraged to monitor aerobic fitness and emphasize aerobic training in all individuals involved with endurance cycling.

These results suggest non-significant changes in BMD occurred within these cyclists. These participants also demonstrated significant changes in some BMC measures. These findings suggest that BMD and BMC measures may change in relatively short time frames, yet more study is needed on the impact of prolonged cycling on BMD among novice cyclists. Spinal osteoporosis has been documented in experienced cyclists. The novice cyclists in this study demonstrated non-significant changes in BMD within a relatively short time frame. Thus as exercise professionals

frequently supervise the training of endurance cyclists, they should be mindful of such potential changes in the athletes they train.

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Table 1

Results of the Analysis of Variance (ANOVA). Comparisons of Aerobic Capacity (AC) and Time to Volitional Failure (TVF).

Effect	Value	F score	Hypothesis df	Error df	Sig
Pre-Post (AC)	.404	5.418	1	8	0.048*
Pre-Post (AC) x Group	.915	43.82	1	8	0.000*
Pre-Post (TVF)	.805	33.108	1	8	0.000*
Pre-Post (TVF) x Group	.853	46.401	1	8	0.000*

Note: Comparison of dependent measures by condition (n=10). * Significant at the $p \leq 0.05$ level.

Table 2

Results of the Analysis of Variance (ANOVA). Comparisons of OMNI RPE.

Effect	Value	F score	Hypothesis df	Error df	Sig
Pre-Post	.996	986.13	1	4	0.000*
Pre-Post x Group	.915	43.20	1	4	0.003*
Stages	.986	17.07	4	1	0.179
Stages x Group	.848	1.392	4	1	0.556
Pre-Post x Group	.163	.130	3	2	0.934
Pre-Post x Stages x Group	.885	5.126	3	2	0.168

Note: Comparison of dependent measures by condition (n=10). * Significant at the $p \leq 0.05$ level.

Table 3

Results of the Analysis of Variance (ANOVA). Comparisons of BMD and BMC.

Effect	Value	F score	Hypothesis df	Error df	Sig
Pre-Post (BMD-Whole Body)	.041	.343	1	8	0.574
Pre-Post (BMD-Whole Body) x Group	.063	.533	1	8	0.486
Pre-Post (BMD-Lumbar)	.083	.721	1	8	0.420
Pre-Post (BMD-Lumbar) x Group	.029	.636	1	8	0.636
Pre-Post (BMC LARM)	.042	.351	1	8	0.570
Pre-Post (BMC LARM) x Group	.035	.290	1	8	0.605
Pre-Post (BMC LARM FATMASS)	.513	8.420	1	8	0.02*
Pre-Post (BMC LARM FATMASS) x Group	.137	1.275	1	8	0.292
Pre-Post (BMC LEANMASS LARM)	.435	6.157	1	8	0.038
Pre-Post	.000	.001	1	8	0.979

(BMC LEANMASS LARM) x Group					
Pre-Post (LARM LEAN BMC)	.425	5.923	1	8	0.041
Pre-Post (LARM LEAN BMC) x Group	.000	.000	1	8	0.999
Pre-Post (LARM TOTAL MASS)	.331	3.961	1	8	0.082
Pre-Post (LARM TOTAL MASS) x Group	.048	.402	1	8	0.544
Pre-Post (LARM PFAT)	.829	38.716	1	8	0.000
Pre-Post (LARM PFAT) x Group	.195	1.943	1	8	0.201
Pre-Post (RARM BMC)	.130	1.193	1	8	0.306
Pre-Post (RARM BMC) x Group	.009	.069	1	8	0.800
Pre-Post (BMC RARM FATMASS)	.003	.023	1	8	0.882
Pre-Post (BMC RARM	.124	1.128	1	8	0.319

FATMASS) x Group					
Pre-Post (BMC LEANMASS RARM)	.441	6.322	1	8	0.036
Pre-Post (BMC LEANMASS RARM) x Group	.004	.032	1	8	0.863
Pre-Post (RARM LEAN BMC)	.437	6.201	1	8	0.038
Pre-Post (RARM LEAN BMC) x Group	.004	.033	1	8	0.860
Pre-Post (RARM TOTAL MASS)	.213	2.167	1	8	0.179
Pre-Post (RARM TOTAL MASS) x Group	.007	.056	1	8	0.819
Pre-Post (RARM PFAT)	.839	41.757	1	8	0.000
Pre-Post (RARM PFAT) x Group	.049	.411	1	8	0.540

Note: Comparison of dependent measures by condition (n=10). * Significant at the $p \leq 0.05$ level.

APPENDIX I: CALL FOR PARTICIPANTS

WKU DOCTOR OF PHYSICAL THERAPY

Seeking Young Adults for Research Study

Are you interested in the areas of exercise science and physical therapy?
Would you like to know how regular, vigorous exercise may contribute to overtraining?
Are you a physically active 18-30 year old man?

If you answered YES to any of these questions, you may qualify for participation in our latest research study:

Faculty and students in the Doctor of Physical Therapy Program at Western Kentucky University are conducting a research study investigating the influence of regular, vigorous exercise may contribute to overtraining.

- Participants will be expected to travel to the Medical Center Health Complex at Western Kentucky University to take part in this study.
- Individuals will visit the laboratory on two occasions for approximately 60 minutes each.

Criteria for the Study

Participants must be:

- Men between the ages of 18 to 30
- Non-cyclist
- Physically active, participating in a regular exercise routine (30 minutes, 3 days per week, for a period of at least 3 months)

If interested please contact:

Wade T. Weatherholt
270-615-1500
wade.weatherholt887@topper.wku.edu

Ryne S. McMullen
502-409-0004
ryne.mcmullen197@topper.wku.edu

APPENDIX II: INCLUSION/EXCLUSION CRITERIA

Inclusion

- Participants must have regular exercise routine (30 minutes, 3 days per week, for a period of at least 3 months)
- Male individuals 18-30 years
- Ability to transport independently to our exercise lab on two occasions, (discuss timing for control group) making concessions with class or work schedule

Exclusion

- ACSM cardio risk factors (high risk ,which equates to 1 or more of the following signs/symptoms OR known cardiovascular, pulmonary, and/or metabolic disease)
    - Pain, discomfort, (for other angina equivalent) in the chest, neck, jaw, arms, or other areas that may result from ischemia
    - Shortness of breath at rest or with mild exertion
    - Dizziness or syncope
    - Orthopnea or paroxysmal nocturnal dyspnea
    - Ankle edema
    - Palpitations or tachycardia
    - Intermittent claudication
    - Known heart murmur
    - Unusual fatigue or shortness of breath with usual activities
- Neuromuscular condition
- Lower extremity or back injuries impairing cycling abilities (including surgery within the past year or an injury within the past 6 months)
- Presents risk for coronary artery disease, pulmonary pathology (either obstructive or restrictive, including exercise induced asthma)

APPENDIX III: MEDICAL SCREENING FORM

Please complete the following questions to the best of your ability

PATIENT INFORMATION

Name:_____ Date of Birth:_____

Telephone #:_____ Gender: M_____ F_____ Height: _____ Weight: _____

Emergency Contact Name: _____ AND Tel #: _____

MEDICAL HISTORY (Explain "yes" answers below. Circle questions for which you don't know answers to.)

		Yes	No
a)	Have any close relatives (<50 years of age) ever experienced:		
	a. Premature death (sudden or otherwise) from cardiovascular disease	☐	
	b. Premature morbidity or disability from cardiovascular disease	☐	
	c. Specific knowledge of:		
	1) Hypertrophic cardiomyopathy	☐	☐
	2) Dilated cardiomyopathy	☐	☐
	3) Long QT syndrome	☐	☐
	4) Marfan's syndrome	☐	☐
	5) Clinically important arrhythmias	☐	☐

b) Have you ever been told you have **OR** experienced any of the following conditions?

	Yes	No		Yes	No
Diabetes	☐	☐	Heart Murmur	☐	☐
High Blood Pressure	☐	☐	Chest Pain	☐	☐
High Cholesterol	☐	☐	Dizziness	☐	☐
Shortness of Breath	☐	☐	Palpitations/racing heart	☐	☐
Persistent pain at night	☐	☐	Arthritis	☐	☐
Numbness/tingling	☐	☐	Current smoker or quit within last 6 months	☐	☐
Problems with balance/falling	☐	☐	Swelling in legs or ankles	☐	☐
Unexpected weight loss	☐	☐	Any other health concerns	☐	☐

Please explain: _____

c) Have you ever fainted during or after exercise?
d) Have you ever been dizzy during or after exercise?
e) Have you ever had chest pain during or after exercise?
f) Have you ever had excess shortness of breath during or after exercise?
g) Do you use more than 1 pillow under your head to sleep at night?
h) Do you ever wake up short of breath?
i) Have you ever had pain or cramping in your legs during exercise?
j) Do you use an assistive or prosthetic device?

k) Please list any surgeries or other conditions for which you have been hospitalized in the last five years, including the date and reason for the surgery or hospitalization.

DATE REASON FOR SURGERY/HOSPITALIZATION

_____

_____

l) Please list any **over-the-counter** and **prescription** medications that you are currently taking.

_____

_____

m) What is your current physical activity level? (Please include type of activity and frequency)

_____

Participant's signature _____ Date _____

Witness's signature _____ Date _____

APPENDIX IV; INFORMED CONSENT (CYCLISTS0

Note: Letter of Informed Consent to be printed on letterhead for Doctor of Physical Therapy Program, Western Kentucky University

Co-Principal Investigators: Wade Weatherholt and Ryne McMullen
Supervising Investigators: Donald Hoover, PT, Ph.D., CSCS and Mark Schafer, PhD
School/Department/Division: Doctor of Physical Therapy Program, Western Kentucky University
Telephone: 270-745-4378
Email: don.hoover@wku.edu

Project Title: Monitoring of Overtraining Status: Assessment of Physiological and Psychological Markers in Recreational Cyclists Engaged in Cross-Country Cycling

Investigators: Don Hoover, PT, PhD, Doctor of Physical Therapy Program (270-745-4378) and Mark Schafer, Department of Kinesiology (270-745-5857)

You are being asked to participate in a project conducted through Western Kentucky University. The University requires that you give your signed agreement to participate in this project.

The investigator will explain to you in detail the purpose of the project, the procedures to be used, and the potential benefits and possible risks of participation. You may ask him/her any questions you have to help you understand the project. A basic explanation of the project is written below. Please read this explanation and discuss with the researcher any questions you may have.

If you then decide to participate in the project, please sign on the last page of this form in the presence of the person who explained the project to you. You should be given a copy of this form to keep.

1. **Nature and Purpose of the Project:** The purpose of this study is to examine the effects of repeated days of vigorous physical activity upon numerous physiological and psychological markers exhibited during a cross-country cycling event completed by recreational cyclists. Two groups of participants will be involved in this study: one group will consist of individuals who will ride bicycles across the United States to raise awareness about Alzheimer's disease, and another group of individuals will serve as age-matched controls but carry on with their normal daily activities during this same time frame. *I am part of the group of individuals who will ride my bicycle across the United States.* Numerous laboratory measures of fitness will be collected on both groups of participants, prior to and following the completion of the bicycle ride across the country. Additional measures will also be collected on the cyclists each day during their trip across the country.

2. **Explanation of Procedures:** Before I participate in any physical activity, I will

undergo a health examination to screen for coronary artery disease risk factors along with signs/symptoms of cardiovascular, pulmonary, and/or metabolic disease. The aim of this screening is to minimize risk to participants and to determine my suitability for inclusion in this study. Each component of this screening will be explained to me, and I will have an opportunity to have my questions answered. This, and all testing that will follow, will take place in the Human Performance Laboratory in the Doctor of Physical Therapy Program located on the campus of Western Kentucky University.

If I meet the inclusion criteria, members of the research team will collect relevant physiological data during two laboratory sessions, one prior to the ride across the country and one following its completion. These sessions will occur at a time agreed upon by both researcher and participant. The testing will include measures of resting blood pressure and heart rate, height and weight, a VO2 max test, blood lactate testing (which includes a finger prick using universal precautions) and a DEXA scan, which assesses body composition and bone mineral density. I understand that each session is expected to last approximately 60 minutes or less.

As I ride my bicycle across the country, I will also undergo daily collection of data. This will include daily measures of body weight, heart rate, blood pressure, blood lactate testing (which includes a finger prick using universal precautions), and two surveys which assess psychological variables that may change in response to the physical demands of riding a bicycle across the nation. I understand that this daily data collection will occur each morning, day, and evening and is expected to require approximately 45 minutes or less each day.

3. **Discomfort and Risks:** I recognize the risks of participating in this study are minimal. Potential risks and discomforts of this study are fatigue, delayed-onset muscle soreness (DOMS), muscular injury, shortness of breath in response to physical activity, and localized fatigue. Sudden cardiac death is a potential risk with any form of exercise, however the inclusion and exclusion criteria listed above was crafted to mitigate this risk. I also recognized that getting my finger prick for lactate measurements will be a requirement, causing some temporary discomfort and light bleeding.

4. **Benefits:** I recognize that I may gather possible personal benefits including increased knowledge regarding my physical capabilities. I also recognize I have been informed that my participation in this research may not benefit me or my health. Potential benefits to others may result from the knowledge gained from my participation in this research study. I have been informed that my decision to participate, refuse to participate, decision to withdraw from the study will not adversely affect me in any way. I understand that individuals are not being compensated in any way for participating in this study.

5. **Confidentiality:** I understand any information acquired from this study in which I might be identified will remain confidential. All printed records will be stored in a locked file cabinet in a locked room; digital files and other software application files

related to my participation in this study will be stored on computers maintained by Western Kentucky University. Only the investigator and members of the research team will have access to these records, and all records related to my participation will be destroyed after final presentation or publication of the results of this study. If information learned from this study is published, I will not be identified by name. By signing this form, however, I allow the research study investigator to make my records available to the Western Kentucky University Institutional Review Board (IRB) Office and regulatory agencies as required by law.

I understand that although my confidentiality in this study is protected, this confidentiality may not be absolute or perfect. There are some situations where research staff may be required by law to share information that I have provided

6. **Refusal/Withdrawal:** Refusal to participate in this study will have no effect on any future services you may be entitled to from the University. Anyone who agrees to participate in this study is free to withdraw from the study at any time with no penalty.

You understand also that it is not possible to identify all potential risks in an experimental procedure, and you believe that reasonable safeguards have been taken to minimize both the known and potential but unknown risks.

_____ _____

Signature of Participant Date

_____ _____

Witness Date

THE DATED APPROVAL ON THIS CONSENT FORM INDICATES THAT
THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY
THE WESTERN KENTUCKY UNIVERSITY INSTITUTIONAL REVIEW BOARD
Paul Mooney, Human Protections Administrator
TELEPHONE: (270) 745-2129

APPENDIX V: INFORMED CONSENT (MATCHED CONTROLS)

Project Title: Monitoring of Overtraining Status: Assessment of Physiological and Psychological Markers in Recreational Cyclists Engaged in Cross-Country Cycling

Investigators: Don Hoover, PT, PhD, Doctor of Physical Therapy Program (270-745-4378) and Mark Schafer, Department of Kinesiology (270-745-5857)

You are being asked to participate in a project conducted through Western Kentucky University. The University requires that you give your signed agreement to participate in this project.

The investigator will explain to you in detail the purpose of the project, the procedures to be used, and the potential benefits and possible risks of participation. You may ask him/her any questions you have to help you understand the project. A basic explanation of the project is written below. Please read this explanation and discuss with the researcher any questions you may have.

If you then decide to participate in the project, please sign on the last page of this form in the presence of the person who explained the project to you. You should be given a copy of this form to keep.

1. **Nature and Purpose of the Project:** The purpose of this study is to examine the effects of repeated days of vigorous physical activity upon numerous physiological and psychological markers exhibited during a cross-country cycling event completed by recreational cyclists. Two groups of participants will be involved in this study: one group will consist of individuals who will ride bicycles across the United States to raise awareness about Alzheimer's disease, and another group of individuals will serve as age-matched controls but carry on with their normal daily activities during this same time frame. *I am part of the group of individuals who will serve as age-matched controls.* Numerous laboratory measures of fitness will be collected on both groups of participants, prior to and following the completion of the bicycle ride across the country. Additional measures will also be collected on the cyclists each day during their trip across the country.

2. **Explanation of Procedures:** Before I participate in any physical activity, I will undergo a health examination to screen for coronary artery disease risk factors along with signs/symptoms of cardiovascular, pulmonary, and/or metabolic disease. The aim of this screening is to minimize risk to participants and to determine my suitability for inclusion in this study. Each component of this screening will be explained to me, and I will have an opportunity to have my questions answered. This, and all testing that will follow, will take place in the Human Performance Laboratory in the Doctor of Physical Therapy Program located on the campus of Western Kentucky University.

If I meet the inclusion criteria, members of the research team will collect relevant

physiological data during two laboratory sessions, one prior to the ride across the country and one following its completion. These sessions will occur at a time agreed upon by both researcher and participant. The testing will include measures of resting blood pressure and heart rate, height and weight, a VO_2 max test, blood lactate testing (which includes a finger prick using universal precautions) and a DEXA scan, which assesses body composition and bone mineral density. I understand that each session is expected to last approximately 60 minutes or less.

3. **Discomfort and Risks:** I recognize the risks of participating in this study are minimal. Potential risks and discomforts of this study are fatigue, delayed-onset muscle soreness (DOMS), muscular injury, shortness of breath in response to physical activity, and localized fatigue. Sudden cardiac death is a potential risk with any form of exercise, however the inclusion and exclusion criteria listed above was crafted to mitigate this risk. I also recognized that getting my finger prick for lactate measurements will be a requirement, causing some temporary discomfort and light bleeding.

4. **Benefits:** I recognize that I may gather possible personal benefits including increased knowledge regarding my physical capabilities. I also recognize I have been informed that my participation in this research may not benefit me or my health. Potential benefits to others may result from the knowledge gained from my participation in this research study. I have been informed that my decision to participate, refuse to participate, decision to withdraw from the study will not adversely affect me in any way. I understand that individuals are not being compensated in any way for participating in this study.

5. **Confidentiality:** I understand any information acquired from this study in which I might be identified will remain confidential. All printed records will be stored in a locked file cabinet in a locked room; digital files and other software application files related to my participation in this study will be stored on computers maintained by Western Kentucky University. Only the investigator and members of the research team will have access to these records, and all records related to my participation will be destroyed after final presentation or publication of the results of this study. If information learned from this study is published, I will not be identified by name. By signing this form, however, I allow the research study investigator to make my records available to the Western Kentucky University Institutional Review Board (IRB) Office and regulatory agencies as required by law.

I understand that although my confidentiality in this study is protected, this confidentiality may not be absolute or perfect. There are some situations where research staff may be required by law to share information that I have provided.

6. **Refusal/Withdrawal:** Refusal to participate in this study will have no effect on any future services you may be entitled to from the University. Anyone who agrees to participate in this study is free to withdraw from the study at any time with no penalty.

(consent form continued)

You understand also that it is not possible to identify all potential risks in an experimental procedure, and you believe that reasonable safeguards have been taken to minimize both the known and potential but unknown risks.

_____ _____

Signature of Participant Date

_____ _____

Witness Date

THE DATED APPROVAL ON THIS CONSENT FORM INDICATES THAT
THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY
THE WESTERN KENTUCKY UNIVERSITY INSTITUTIONAL REVIEW BOARD
Paul Mooney, Human Protections Administrator
TELEPHONE: (270) 745-2129

APPENDIX VI: OMNI SCALE OF PERCEIVED EXERTION

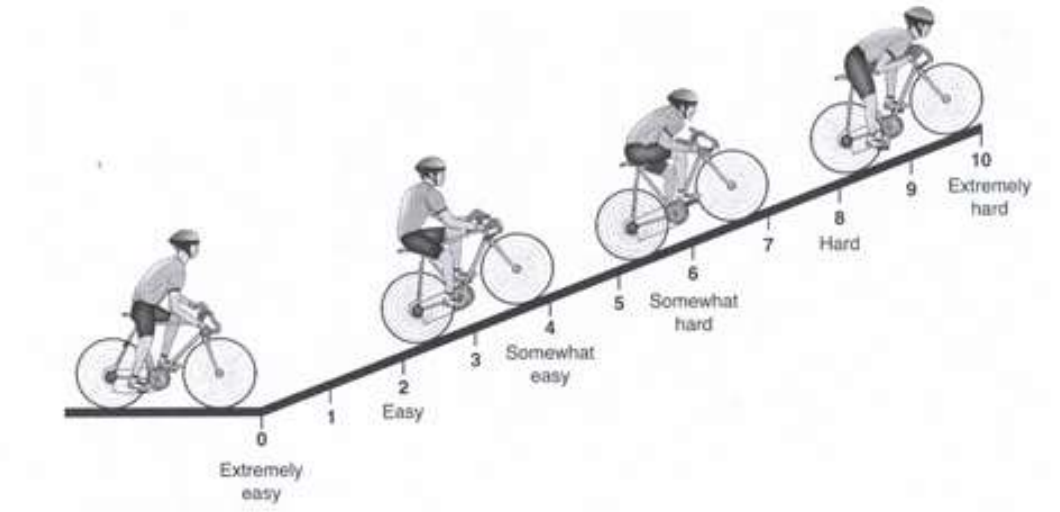

Figure 2.1 OMNI Picture System of Perceived Exertion for adult bicycle exercise.

http://www.fergsfitness.com/Pictures/omni%20cycle%20adult.png

APPENDIX VII: PARTICIPANT INSTRUCTIONS FOR THE GRADED EXERCISE TEST

Instructions for Testing Session 1

"You will warm up by riding your bicycle on the trainer for 10 minutes. This will allow you to become familiar with exercising while breathing through a mouthpiece with nose clipped, as well as to prepare your body for this testing session. During this time you should select a gear ratio which is most efficient for the workload. Once you've selected the gear ratio, you will not be allowed to shift throughout the remainder of the testing protocol. Please let us know if you experience unusual discomfort while exercising or if you wish to stop exercising. Are you ready to begin the warm up?"

Begin the warm up, allowing the participant to pedal at a self-selected cycling cadence for 10 minutes. Monitor the power output throughout the warm up period. Do not allow the participant to exceed the established power to weight ratio (150 W) during the warm up.

After the warm up is complete, set up the Computrainer to run the Germania course, and complete the final steps necessary to run the GXT. During the protocol, each rider will cycle against a "base resistance" of 50W, and s/he will begin the ramp protocol at 0% grade. The grade will increase 1% every 2 minutes, increasing the effort necessary to remain pedaling. Every two minutes the grade will be increased until the participant fails to maintain a minimum pedaling cadence of 60 revolutions per minute (rpm). Participants will be expected to remain seated ("in the saddle') at all times during the testing.

"Today's testing session consists of an incremental to maximal exercise protocol, which is commonly used to determine an individual's maximal aerobic capacity or VO_2 max. This is a high intensity test in which you are expected to give your very best effort, and we will take physiological measures throughout the testing. You should use the pedaling cadence which is most efficient for the workload.

Each stage will consist of 2 minutes at a workload based upon your bodyweight, and each stage will get incrementally more difficult. The goal is to complete as many stages as possible, while maintaining a minimum cadence of at least 60 revolutions per minute and while remaining in the saddle. The test will be deemed completed when you are unable to maintain either of these criteria, or if you request to stop the testing.

We will regularly ask how you are doing throughout the test. Because you're wearing the facemask, you'll answer using the universal hand signals for this type of testing – thumb up for "okay", thumb sideways for "close to max", thumb down for "ready to stop". Each time we ask you how you're doing, we will use these hand signals too. Are you ready to begin the testing protocol?"

Begin the testing protocol, allowing the participant to pedal at a self-selected cycling cadence and gear ratio. Monitor all physiologic and subjective measures throughout the testing period. Stop the test when the participant drops below 60 rpm or leaves the saddle; allow the participant to engage in active cool-down on the bike and continue collecting physiologic data until the physiological data suggests the participant has sufficiently recovered.

APPENDIX VIII: DATA COLLECTION SHEETS

Laboratory Data Collection

Condition (circle): Pre vs Post RAUS

Participant Number: _____ Date:_____ Age:_____

Height (cm): _____ Weight (kg): _____ Seat height (cm): _____

Bike Make: _____ Model:_____ Size (cm):_____ Pedal system:_____

Rear tire pressure (psi): _____

What time of day do you generally exercise: _____

Resting Vitals

Vital Sign	Pre:	Post:
Heart Rate		
Blood Pressure		
Respiration Rate		

Computrainer: Data included in separate Excel file

Comments: How long ago did he eat? Did the participant successfully complete the trial? How does she feel after the test? Etc?

_____
_____
_____
_____
_____
_____

DEXA data:

Body composition value: _____

BMD value Axial Spine: _____

BMD value Femoral: _____

GXT data:

Participant number: _____ Date: _____ Gear combination: _____ CT Calibration (Ergo): _____

Name: _____ Resting HR: _____ Wt (kg): _____ CT Calibration (SpinScan): _____

	Power: Wt Ratio	Workload (W)	HR (bpm)	OMNI (0-10)	VO2	VCO2	RER	Blood Lactate Values	SpinScan (Ave)	SpinScan L	SpinScan R	ATA L	ATA R	RPM
Stage 1 0-2 min														
Stage 2 2-4 min														
Stage 3 4-6 min														
Stage 4 6-8 min														
Stage 5 8-10 min														
Stage 6 10-12 min														
Stage 7 12-14 min														
Stage 8 14-16 min														
Stage 9 16-18 min														

Time to Max: _____ Max HR: _____

Comments: